deforming the sequential activity maps using registered sequential SPECT-CT scans and with the parallelogram method. In 9 out of 11 cases the Olinda/EXM calculations of average dose absorbed by the kidneys was below the dose calculated by Raydose (range [8,51]%). In 2 cases the kidney average dose, as calculated with the Olinda/EXM method, were below the dose calculated with Raydose (-6,-26)%. DVHs and 3D dose maps provided valuable information regarding the uniformity of the dose distribution which would have been otherwise missed with an organ level approach.

Conclusions: Following the experience obtained in this pilot study we conclude that it is feasible to implement in routine delivery of PRRT therapy patient specific 3D dose calculation using Raydose. Our workflow included deformable image registration to accurately account for changes in both patients anatomy and activity distribution during the course of the therapy. Work is in progress to use Raydose to optimise PRRT treatments in terms of fractionation, combination of isotopes and correlation with toxicity data.

PO-0895

3D transperineal ultrasound image guidance methods for prostate SBRT radiotherapy treatment

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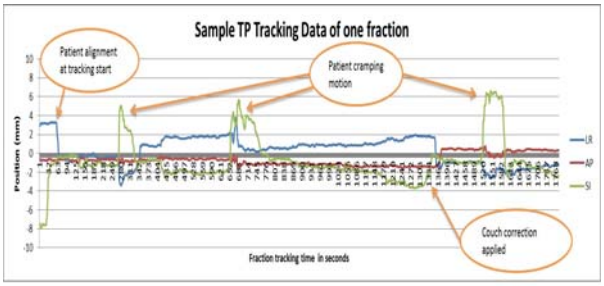
Purpose/Objective: A second generation 3D ultrasound image guidance (USIG) system (Clarity, Elekta Inc), which allows for transperineal (TP) localization and intra-fractional tracking of the prostate has been evaluated for use in stereotactic body radiation therapy (SBRT) of the prostate at our institution. Here we describe our implementation of a prostate SBRT TP USIG protocol.

Materials and Methods: After the development of an initial clinical USIG based workflow for standard fractionation treatment, we extended the workflow to allow for increased positional verification required for SBRT. Our SBRT treatment protocol gives 36.25 Gy in 5 fractions, every other day and utilizes USIG to ensure target coverage. The planning target volume (PTV) is defined as the CTV plus a 3 mm margin posteriorly and 5 mm in all other dimensions. Patient alignment has to be approved by a physicist and a physician, both of whom have to be experienced in reading US images. During intra-fractional US-tracking, corrective action is taken if the target migrates more than 3 mm for more than 5 seconds in any of three orthogonal coordinates. Patients were positioned according to SBRT protocol and aligned to skin marks using treatment room lasers. TP USIG was performed and shifts from tattoo were performed and recorded. For purpose of redundant verification, a transabdominal (TA) USIG was performed (BAT, Nomos Inc.) while TP USIG tracking was on. Treatment was conducted using TP USIG tracking.

Results: A total of 57 fractions delivered to 11 prostate cancer patients were retrospectively analyzed for workflow performance, patient motion and agreement between two US image guidance devices (TA and TP). The mean of initial USIG shifts from skin marks based on TP positioning for all 11 patients was 0.24, 1.25, and -4.38 mm in left-right (LR), anterior-posterior (AP), and superior-inferior (SI) directions respectively. The average difference between the two US systems (TP vs TA) for all patients was -0.05, -0.02, and -0.04 mm in LR, AP and SI directions respectively. The respective standard deviations were 0.14, 0.34 and 0.27 mm. Patient alignment was corrected if indicated by tracking. Intra-fractional tracking data was analyzed and will be presented (see Image 1).



Conclusions: 11 prostate SBRT patients treated in our clinic were localized using two USIG systems which showed average agreement to less than 0.5 mm in all three principle directions (LR, AP, SI). Intra-fraction tracking allowed us to reduce treatment planning margins to 3 mm posteriorly and 5 mm elsewhere, due to the ability to track and correct for motion during treatment.

PO-0896

Radiotherapy quality assurance in the NIHR ProtecT trial

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Purpose/Objective: ProtecT is a phase 3 clinical trial [1] comparing prostate cancer mortality for patients with clinically localised prostate cancer randomly assigned to active monitoring, radical prostatectomy or 3D conformal external beam radiotherapy.

Trial results are anticipated for 2016 and the purpose of this work is to assess the quality of treatment plans produced for participants randomised to receive radiotherapy.

Materials and Methods: 545 of the participants, recruited across 9 UK cities were randomised to receive radiotherapy. 3D conformal external beam radiotherapy was used to deliver 74Gy to the isocentre in 2Gy fractions in 2 phases. During phase 1 a dose of 56Gy was prescribed to a target volume including prostate and seminal vesicles and during phase 2 a dose of 18Gy is prescribed to a target volume surrounding prostate only. To ensure consistency and comparability of radiotherapy between centres a detailed radiotherapy protocol was developed. To assess the quality of radiotherapy plans, 13 quantities were measured and a deviation recorded

if the corresponding objective was not met (Table 1). Radiotherapy plan data was submitted by treatment centres in DICOM or RTOG format and 52 randomly selected plans were processed with the Computational Environment for Radiotherapy Research (CERR) software [2] which enabled i) outlining of target and organ-at-risk structures and ii) dose distribution and dose volume histograms to be assessed.

	Quantity	Objective
Phase 1 (56Gy in 28#)	PTV1 V95% (53.2Gy)	≥99%
Phase 2 (18Gy in 9#)	PTV2 V95% (17.1Gy)	≥99%
Summed doses (i.e., 74Gy in 37#)	ICRU Max D1.8cc	≤105% (77.7Gy)
	Bladder V74Gy	<25%
	Bladder V67Gy	<50%
	Rectum V74Gy	≤3%
	Rectum V70y	<25%
	Rectum V67Gy	<30%
	Rectum V55.5Gy	<50%
	Left femoral head D2cc	<55Gy
	Right femoral head D2cc	<55Gy
	# Unique gantry angles	3 or 4
	Min. AP separation of 44Gy isodose and posterior rectal contour along midline	>0 mm

Table 1: Summary of quantities assessed during review of radiotherapy plans.

Results: The total number of deviations identified was ~11% of the total possible. 81% of plans had two or fewer deviations indicating good adherence to the trial protocol (Figure 1). 64% of deviations were related to the rectum. There were 5 dose volume objectives associated with the rectum and it was recognised that failure to meet one rectal constraint generally corresponded with further deviations.
All patient plans used 3 or 4 gantry angles in a 'pelvic-brick' beam distribution with or without the posterior beam. No patient failed the ICRU Max D1.8cc constraint.

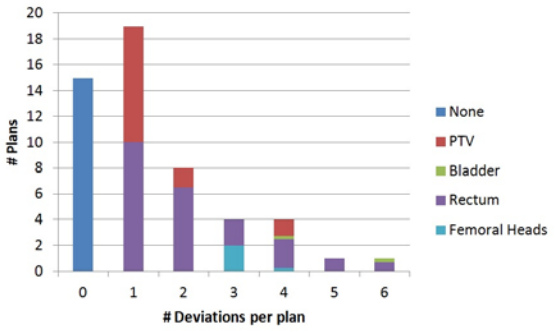

Figure 1: Histogram showing number of deviations recorded per plan reviewed. The type of deviation recorded is indicated by the colour of the bars.

Conclusions: Deviation from the clinical trial protocol has the potential to confound the study question and quality assurance is therefore essential when comparing different treatments. Our analysis of a subset of the radiotherapy plans demonstrates good understanding and adherence to the ProtecT protocol.

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References:

[1] J. A. Lane, J. L. Donovan et al., Active monitoring, radical prostatectomy, or radiotherapy for localised prostate cancer: study design and diagnostic and baseline results of the ProtecT randomised phase 3 trial, The Lancet Oncology, Volume 15, Issue 10, September 2014, Pages 1109-1118
[2] A Computational Environment For Radiotherapy Research, CERR homepage, http://www.cerr.info/about.php

PO-0897

A critical evaluation of 2D-ARRAYs (1500, SRS1000 and 729) and OCTAVIUS 4D phantom for QA of FFF prostate plans

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Purpose/Objective: Quality assurance (QA) of volumetric-modulated radiotherapy (VMAT) has developed substantially in recent years. One of the most important roles of dosimetric verification is to detect errors in plan implementation on the treatment machine. Such errors include incorrect mechanical settings, differences in doses, and shifts in the multileaf collimators. To verify that the treatment plan is correct, it is necessary to use proper measuring tools (e.g., 2D and 3D detector arrays) in addition to an analytical method (e.g., gamma method) that includes tolerance and passing criteria that are sufficiently sensitive to achieve reliable results. The detector arrays, however, are limited by their resolution. Understanding the limitations of these devices is therefore crucial. The aim of the work was to characterize the sensitivity to induced errors of 2D-arrays for FFF prostate plan verification.

Materials and Methods: The new 2D ion chamber array 1500 and the well-known arrays, seven29 and SRS1000 with rotational phantom cylindrical Octavius® 4D and Verisoft 6.0 software (PTW, Freiburg, Germany) were used to determine the sensitivity to induced errors. Measured and calculated dose distributions of VMAT high-fractionated FFF prostate plans were compared using the 3D gamma analysis by global (maximum) and local dose methods with a 5% threshold for various tolerance parameters DTA [mm] and DD [%] were 1.0; 1.5; 2.0; 2.5; 3.0; 3.5. The sensitivity of the 2D-arrays was tested using the errors inserted into VMAT plan: a collimator rotation angle (1; 2; 3 degree), dose (difference in %: 0.5; 1.0; 2.0) and MU errors (5MU was missing in each field at the end of gantry position). Later, the erroneous plans were compared to measure error-free dose distributions on arrays on a linear accelerator (TrueBeam, Varian).

Results: The results for each of the arrays analyzed differed and were strictly dependent on the resolution of the detector. The results obtained were as follow: for gamma criteria 2/2 (DTA[mm]/DD[%]): SRS1000 (L99.5; G99.9), 1500 (L95.8; G99.0), 729 (L92.2; G97.0); for 3/3: SRS1000 (L99.0; G100.0), 1500 (L99.4; G100.0), 729 (L98.9; G99.7). The highest differences were observed for inserted errors: coll 3°, dose lowered by 2.0% and MU errors (L2/2; 1500): 94.0; 89.0; 95.0, respectively. The sensitivity of arrays to errors was presented in Fig.1.